



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| <p>(54) Title: NOVEL FOOD COMPOSITIONS<br/><br/>(57) Abstract<br/><br/>The present invention relates to food compositions which comprise undenatured potato protein as an ingredient, more specifically to food compositions in which all or a portion of the animal protein, milk protein, fat or hydrocolloids is replaced by undenatured potato protein and to a process for preparing such undenatured protein.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## NOVEL FOOD COMPOSITIONS

### FIELD OF THE INVENTION

10 The present invention relates to the use of potato protein in food compositions.

### BACKGROUND OF THE INVENTION

15 Potato protein has traditionally been regarded as a waste product of starch manufacture. However, its nutritional qualities (i.e. protein efficiency ratio and biological value) has been shown to be greater than that of casein and comparable to that of whole  
20 egg (Kapoor et al. 1975; Stegemann, 1977); Knorr, 1978). Potato protein is rich in lysine and theoretically an excellent supplement for lysine-poor proteins such as those of cereals. Despite its unique nutritional qualities, potato protein is currently only used as animal feed, because the product exhibits  
25 a number of serious drawbacks.

One of the major drawbacks is that the recovery of potato protein from the effluent of potato starch mills is commonly carried out on an industrial scale by heat coagulation (Oosten (1976); De Boer & Hiddink, 1977; Knorr et al, 1977). Due to the  
30 heat coagulation, potato protein becomes denatured and as a consequence becomes devoid of functional properties, i.e. emulsifying capacity, foaming capacity, thermogelling capacity, water binding capacity. Even the most essential requirement for its application in the food industry, i.e. solubility in water,  
35 cannot be met.

Although there are a handful of publications about the recovery of undenatured potato protein, see for example Jackman & Yada (J. Food Science (1988) 53:1427), Holm & Eriksen (J. Food Technol. (1980) 15:71) and GB 1,520,738, it is not clear whether  
40 or how such undenatured potato protein can be used in food compositions.

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## DETAILED DESCRIPTION

The present invention relates to a food composition which comprises un-denatured potato protein as an ingredient and to a method for preparing such un-denatured potato protein.

In particular, this invention relates to the use of un-denatured potato protein as a substitute for protein, fat or hydrocolloids in food compositions. This allows for a diet based on vegetable proteins, with high nutritional value. Consequently, in contrast to known food compositions which contain protein, fat or hydrocolloid substitutes which are animal or milk proteins, food compositions according to the invention may be used by people who prefer not to use such proteins.

In this context 'food composition' refers to any substance containing nutrients, whether for human or animal consumption, whether comprised of a single ingredient or a mixture of ingredients, whether liquid, liquid containing or solid, whether primarily carbohydrate, fat, protein or any mixture thereof, whether edible per se or requiring processing like cooking, mixing, cooling, mechanical treatment and the like.

The un-denatured potato protein used in the food composition is preferably isolated from potato fruit juice, a waste product of the starch manufacturing industry. Both diluted and undiluted potato fruit juice may be used. Other suitable sources of un-denatured potato protein include for example potato peel extracts and effluent streams from potato processing industries other than the potato-starch industry.

In this context, 'un-denatured potato protein' refers to potato protein which has retained most of its intrinsic functional properties, such as emulsifying capacity, solubility, foaming capacity, water binding capacity and thermogelling capacity, on isolation. As a consequence, its functional properties will be better than those of denatured potato protein and at least as good as those of soy protein.

In the method of the invention, un-denatured potato protein is prepared by a low-temperature process comprising conditioning (pre-treatment), ultrafiltration, diafiltration and, optionally, drying. The un-denatured potato protein of the invention is recovered from a potato protein containing fraction, such as potato fruit juice, after the latter has been conditioned. During conditioning undesired particles and microorganisms are removed,

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which allows for high initial fluxes. In order to retain functional activities, in particular foaming capacity, conditioning should be carried out at a temperature which does not exceed 40°C. Preferably, the potato protein containing fraction is conditioned by means of flocculation, which encapsulates the contaminations, and centrifugation. Flocculation may be carried out at a pH from about 7.0 to 8.0, preferably at pH 7.5, and at a temperature of from about 10°C to about 40°C, preferably at a temperature of from about 20°C to about 30°C. The flocculant is preferably food-grade. In one preferred embodiment, flocculation is carried out at room temperature using  $\text{CaHPO}_4$ , which is formed by the addition of a calcium salt and a phosphate compound to the potato protein containing fraction. A suitable calcium:phosphate ratio is about 0.3:0.18. Preferably, from about 0.1 to about 1.0% w/v calcium is used.

The flocculent may be removed from the liquid phase by e.g. filtration, centrifugation, decanting or any other suitable means. If  $\text{CaHPO}_4$  is used for flocculation, the two phases are preferably separated by centrifugation, which will result in a clear supernatant.

The potato protein containing supernatant is concentrated and washed, e.g. by filtration, evaporation, adsorption-elution, or a combination of these methods. Preferably, it is concentrated and washed by filtration. Any ultrafiltration, hyperfiltration or microfiltration membrane which is convenient for the concentration of protein may be used, as long as they retain the undenatured potato protein. Membranes with a cut-off value of from about 3 kDa to 100 kDa are preferably used. Any type of filtration unit can be used. Preferred units are continuous systems, such as a continuous multistage filtration unit or a feed and bleed unit. The temperature during ultrafiltration should not exceed 40°C and is preferably from about 15°C to about 25°C.

In a preferred embodiment, the supernatant is concentrated by ultrafiltration and washed by diafiltration to reduce the concentration of salts, metals, etc. The concentrate is washed with water, preferably in the presence of bisulphite to prevent undesired colour changes of the protein. The amount of washing required depends on the application specification of the final product to be met.

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After washing, the concentrate may be dried. If freeze-dried, freezing should be done in as short a time as possible and preferably the drying temperature should not exceed 35°C. If the preparation is spray-dried the inlet temperature may be from  
5 about 100°C to about 140°C, the product outlet temperature should preferably not exceed 75°C, because higher temperatures will lead to a product with inferior foaming capacities. Preferred temperatures are lower than about 120°C (inlet) and from about 50°C to about 70°C (outlet).

10 If necessary, glycoalkaloid compound levels may be reduced, preferably by enzymatic degradation, e.g. by an enzyme preparation as described in WO 97/04107, since the majority of acid and solvent extraction methods used to remove glycoalkaloids result in the denaturation of the protein and hence in loss of  
15 functional properties.

Undenatured potato protein according to the invention is particularly suitable for the preparation of essentially non-potato food compositions. Non-limiting examples of such food compositions are bakery products, such as bread, cake, biscuits,  
20 pies and pastries; dairy products, such as dairy drinks, desserts, ice, yogurt, cheese, spreads, pudding and ice cream; meat products, both for human and animal consumption, whether fresh, cooked or cured; and fish products, whether processed or unprocessed. Other food compositions which may contain  
25 undenatured potato protein as an ingredient are mayonnaise, soups, sauces, non-dairy spreads, dressings, frozen confectionery, jellified confectionery, such as fruit jellies, jams and jellies and restructured foods, such as reformed fruits and food analogues. The examples illustrate that the use of  
30 undenatured potato protein is especially advantageous in whipped products.

Undenatured potato protein may replace all or a portion of the protein (such as egg albumin, casein or soy protein), fat or hydrocolloids (such as pectin, alginate, gelatine, carrageenan,  
35 xanthan, guar, locust bean gum) in food compositions. In one preferred embodiment of the invention, egg white, milk proteins, fat and hydrocolloids are replaced for about 100% by undenatured potato protein.

Undenatured protein may also be used as a supplement in  
40 lysin-poor food compositions. In another preferred embodiment of

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the invention, undenatured potato protein is used to supplement cereal-based meals.

The following examples illustrate how undenatured potato protein can be used for preparing food products.

5

### EXAMPLES

10 **Example 1** Production of undenatured potato protein (large scale)  
Potato fruit juice obtained from a potato starch manufacturer was used within one or two days of reception for the preparation of potato protein. To 700 l of potato fruit juice 0.3% w/v  $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$  and 0.18% w/v  $\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$  were added. The mixture was stirred for  
15 5 minutes at room temperature. The pH was raised to 7.5 using a 20% w/v NaOH solution. The conditioned potato fruit juice was centrifuged in a disc stack centrifuge for removal of the flocculation, including solids and microorganisms. The supernatant was concentrated about 12 times by ultrafiltration  
20 using a continuous ultrafiltration unit equipped with polyethersulfon membranes, cut-off value 5 kDa. The retentate was washed by means of diafiltration in the presence of bisulphite to minimise polyphenol oxidation. Diafiltration was continued until salts and metal concentrations had reached acceptable levels. The  
25 concentrate was freeze-dried until a dry solid content of 92% was reached. The freeze-dried powder contained 70% protein and no detectable levels of glycoalkaloids (HPLC analysis as described by R. Houben & K. Brunt, J. Chromatography 661, 169-174).

30

**Example 2** Solubility of undenatured potato protein compared to denatured potato protein, whey protein and soy protein.

#### Materials

Undenatured potato protein was prepared essentially as described  
35 in Example 1.

Denatured potato protein was obtained from Emsland-Stärke (Germany).

Whey protein (Espiron 580; 78% protein) was obtained from DMV-International (Holland).

40 Soy protein (Supro 500E; 90% protein) was obtained from Protein Technologies International (Belgium).

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### Method

Of each one of the above-mentioned protein products a 10% (w/w) solution in demineralised water was prepared. After solubilisation (as far as possible), the pH of the solution was adjusted to the desired value by the drop-wise addition of either NaOH or HCl. Subsequently the solution with the adjusted pH value was centrifuged for 10 minutes at 14.000 rpm in an Eppendorf centrifuge after which the dry weights of both starting material and supernatant were determined.

The data obtained are provided in Table 1. These data show clearly that the water solubility of undenatured potato protein is far better than denatured potato protein or soy protein.

Table 1 Solubility of undenatured potato protein

| Sample                     | Percentage of dry weight dissolved |        |        |        |
|----------------------------|------------------------------------|--------|--------|--------|
|                            | as such                            | pH 6.5 | pH 5.5 | pH < 2 |
| Undenatured Potato protein | 80                                 | 64     | 63     | 67     |
| Whey protein               | 79                                 | 83     | 86     | 78     |
| Soy protein                | 53                                 | 49     | 44     | 39     |
| Denatured Potato protein   | 26                                 | 34     | 34     | 22     |

Example 3 Emulsifying properties of undenatured potato compared to lecithin, whey protein, soy protein and casein.

### Materials

Undenatured potato protein: see Example 1.

Denatured potato protein: see Example 2.

Whey protein: see Example 2.

Lecithin (Bolec I 55) was obtained from Quest International.

Soy protein (Supro 500E, 90% protein) was obtained from Protein Technologies International (Belgium).

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Casein (EM7, 90% protein) was obtained from DMV-International (Holland).

#### Method

5 Of each of the above mentioned material a 10% (w/w) solution in demineralised water was prepared. Of each one of these solutions 10 grams was poured into a measuring cylinder after which to each of these samples 70 grams of demineralised water and 20 grams of soy oil was added. Emulsions were prepared by mixing for either 2  
10 or 4 minutes at either 8000, 9500 or 13.500 rpm with an Ultra-Turrax T25. The quality of each emulsion was established by taking photographs using a Sony CCD camera linked to a UP3030P videoprinter (magnification: 337.5 x). The formation of many small and homogeneously formed oil droplets was the major  
15 criterium for establishing emulsifying properties.

#### Results

In order of efficacy, the following emulsifier ranking was obtained:

20 1. lecithin 2. undenatured potato protein 3. whey protein 4. soy protein 5. casein 6. denatured potato protein.

These data underline the potential of undenatured potato protein relative to commercially available protein products in terms of emulsifying power.

25

#### Example 4 Artisanal chocolate mousse made with egg albumin

##### Ingredients

30 1 part of fresh egg white (egg albumin)  
0.4 part of Castor Sugar  
1 part of chocolate  
0.5 part of fresh egg yolk

##### Preparation

The egg albumin was mixed with the aid of an Hobart mixer and an  
whire whip, starting with speed 1 and after formation of a foam  
with speed 3. While beating the sugar was added. The addition of  
the sugar was finished before the foam was beaten stiff. The  
40 chocolate was melted au bain-marie and mixed with the egg yolk.  
This chocolate mixture was added to the beaten egg white during

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mixing with the Hobart mixer and an whire whip at speed 1. The final mixture, the mousse, was cooled down and stored for checking the stability of the mousse the next two days. The mousse showed some drainage and volume loss. The fresh egg yolk  
5 may be replaced by soybean lecithin.

#### Example 5 Artisanal chocolate mousse made with potato protein

##### Ingredients

- 1 part of potato protein solution (for preparation see below)
- 10 0.4 part of Castor Sugar
- 1 part of chocolate
- 0.5 part of fresh egg yolk

##### Preparation

- 15 Powdery samples of the potato protein product of the invention were prepared essentially as described in Example 1. From these samples a solution was made by gently mixing with tap water. The solution contained approximately 10% w/v of potato protein. This is in the same order as the concentration of egg albumin in fresh  
20 egg whites. This solution was beaten in the same way as the egg albumin in Example 4. While mixing, the sugar was added. The addition of the sugar was finished before the foam was beaten stiff. After beaten stiff the chocolate mixture (see Example 4) was added to the beaten potato protein while mixing with the  
25 Hobart mixer and an whire whip at speed 1. The final mixture, the mousse, was cooled down and stored for checking the stability of the mousse the next two days.

The storage stability of this mousse was equal to the one prepared with egg-albumin. The specific volume of this mousse  
30 (ml mousse per gram of material) was in the same order or greater than the mousse prepared with egg-albumin.

This example illustrates how the outstanding emulsification properties of potato protein demonstrated in Example 3 can be advantageously applied in a food product.

35

#### Example 6 Industrial Manufactured Mousse with Milk Proteins

The industrially elaborated mousse has the composition given in Table 2. The product is based on cream (typically 38% fat), milk  
40 protein, sugar, emulsifier/stabiliser blends, flavouring.

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The ingredients are mixed for rehydration of the ingredients, followed by a heat treatment to pasteurize, homogenization and aeration, giving a typical overrun of around 60-100% and packaged. The stability was in the order of one week.

5

Table 2 Mousse comprising milk proteins

|    | Constituent                                   | Vanilla mousse (%) |
|----|-----------------------------------------------|--------------------|
| 10 | Milkfat                                       | 7.0                |
|    | Milk proteins                                 | 11.7               |
|    | Castor Sugar                                  | 11.0               |
|    | Emulsifier (mono-diglycerides of fatty acids) | 2.8                |
| 15 | Stabiliser (modified starch)                  |                    |
|    | Vanilla flavour                               | 0.2                |
|    | Water                                         | 67.3               |

20

Table 3 Mousse containing undenatured potato protein

|    | Constituent                                   | Vanilla mousse (%) |
|----|-----------------------------------------------|--------------------|
|    | Milkfat                                       | 7.0                |
| 25 | Potato proteins                               | 10.0               |
|    | Castor Sugar                                  | 11.0               |
|    | Emulsifier (mono-diglycerides of fatty acids) | 2.8                |
|    | Stabiliser (modified starch)                  |                    |
| 30 | Vanilla flavour                               | 0.2                |
|    | Water                                         | 69.0               |

## 35 Example 7 Industrial manufactured mousse with potato proteins

The industrially elaborated mousse has the composition given in Table 3. The product is based on cream (typically 38% fat), milk protein, sugar, emulsifier/stabiliser blends, flavouring. The

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ingredients are mixed for rehydration of the ingredients, followed by a heat treatment to pasteurize, homogenization and aeration, giving a typical overrun of around 80-150% and packaged. The stability was also in the order of one week.

5

This example shows that undenatured potato protein can be used in whipped food products in such a way that it retains its foaming and emulsifying properties. Therefore, it can replace egg albumin as well as casein.

10

#### Example 8 Meringue containing egg albumin

##### Ingredients

1 part of fresh egg whites (egg albumin)

15 1 part of Castor Sugar

##### Preparation

The egg albumin was mixed with the aid of an Hobart mixer and a whire whip, starting with speed 1 and after formation of a foam with speed 3. While beating the sugar was added. The addition of  
20 the sugar was finished before the foam was beaten stiff. The foam was piped with the aid of notched pipe. The meringue was baked with an ceiling (upper) oven temperature of 145°C and a (bottom) lower oven temperature of 115°C for one hour. The meringue was  
25 further dried in an oven with an ceiling temperature of 95°C and a bottom temperature of 80°C for half an hour.

#### Example 9 Meringue containing potato protein

30 

##### Ingredients

1 part of potato protein solution (for preparation see below)

1 part of castor sugar

Powdery samples of the undenatured potato protein product of the invention were obtained as mentioned in Example 1. From these  
35 samples a solution was made by gently mixing with tap water. The solution contained approximately 10 % of potato protein. This is in the same order as the concentration of egg albumin in fresh egg whites. This solution was beaten in the same way as the egg albumin in Example 8. While mixing, the sugar was added. The  
40 stiff foam was piped and baked in the same way as the egg white meringue of Example 8.

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In contrast to meringues made with egg albumin, one does not observe the flow of foam while baking (the sharp edges formed by piping remained). Furthermore a clear difference was seen in the expansion in the oven. Whereas the meringue in Example 8 showed a fast setting of the foam, resulting in cracks in the meringue due to a small further increase in volume, the meringue from potato protein showed a gradual increase in volume giving rise to a non-cracked meringue with a much larger volume per gram of original foam.

This example illustrates how undenatured potato protein can be used in a bakery product without losing its foaming properties, aerating capacity and foam stability while heated.

#### Example 10 Potato protein as lysine-rich fat replacer

A typical example to illustrate how the unique properties of undenatured potato protein can be advantageously employed in the food segment is presented underneath. In this example the extreme thermogelling properties and the very specific amino acid composition of undenatured potato protein are combined to make a lysin-rich fat replacer. Obviously such a product combines ideally with lysin-poor cereal-based food products.

Oil droplets in a well homogenised emulsion typically exhibit droplet diameters between 1 to 10 micron diameter. The scientific literature claims that the fatty mouthfeel of such emulsions is almost entirely based on the mere presence of such droplets or particles in the solution. Nowadays many fat replacer products exist that are based on this principle. Ingredients for such fat replacers include starch, cellulose, pectin and proteins. For nutritionally optimised products, a potato protein based fat replacer could be desirable.

To test the latter concept, undenatured potato protein of the invention was processed to obtain hollow particles with an average diameter between 2 and 10 micron. Although different techniques are known for the production of such particles, for the purpose of this example we have used a technique described in WO 94/08627 (incorporated herein be reference). In this approach 20 grams of undenatured potato protein was dissolved in 150 ml of water containing 0.75 grams of sodium chloride and subsequently atomised at a temperature of 220°C inlet temperature (92°C outlet

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temperature). To render the hollow protein vesicles formed less water-soluble, after atomising the vesicles were subjected to another heat treatment for 30 minutes at 175°C. Finally, size distribution of the vesicles formed was tested in a Coulter LS particle analyser. According to the data obtained the average particle diameter in this experiment was 7 microns. The resulting powdered vesicles were then added in a concentration of 10% to a pre-gelatinised solution of 6% potato starch (Paselli BC from AVEBE, Holland). After complete homogenisation of the dry potato vesicles in the starch, solution, the sample was tasted. For reference 10% homogenates of respectively egg-protein (Omegalux P19, Henningsen and Van der Burg, Holland) and 10% undenatured potato protein material of the invention in 6% potato starch, were included in the test. The following data summarise the results obtained.

Table 4 Mouthfeel experiment

| Materials                                                     | Mouthfeel |                |
|---------------------------------------------------------------|-----------|----------------|
|                                                               | Sandiness | Fat impression |
| 6% pre-gelatinised potato starch                              | +         | -              |
| + 10% egg-protein                                             | +         | -              |
| + 10% undenatured potato protein                              | ±         | ±              |
| + 10% potato protein vesicles from undenatured potato protein | -         | ++             |

(-) poor; (±) moderate; (+) good; (++) excellent

#### Example 11 Breakfast cereals made with potato protein

Potato protein is rich in lysine and as such an excellent supplement for lysin-poor proteins such as those of cereals. This complementary relationship has not only been historically proven but has also been shown in several scientific publications (e.g. Kofranyi, E. and Jekat, F. Die biologische Wertigkeit von Kartoffelproteinen. Westdeutscher Verlag, Köln (1965). Therefore, in the health food sector, the combination of potato protein and, for example, breakfast cereals is desirable. The following example illustrates one route to provide such a combination.

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Typical starting materials for cereal breakfast foods include corn, wheat and rice. Because of the relatively low protein content of these products, it would be desirable to optimise this protein in terms of amino acid composition. Because of the 'poor-in-lysine' nature of cereal proteins, these products would certainly benefit from a combination with a lysine-rich vegetable protein. Although the preparation of granular-type breakfast products is rather complicated, the incorporation of other ingredients in such a product during dough mixing is easy. Depending upon the desired amino acid balance, the ratio between whole wheat flour and potato protein added can be chosen. Adding up to 300 g potato protein per kg of whole wheat flour, yielded no unfavourable textural changes in the final crumb structure. Apart from granular-type cereals, reasonable amounts of potato protein could be incorporated in other ready-to-serve cereals as long as dosage of the dissolved potato protein is followed by adequate heating to gel the protein completely.

#### Example 12 Pet food made with potato protein

Another example illustrating the wide applicability of undenatured potato protein is in pet food manufacturing. In this field the unique thermogelling properties of the protein can be used in waterbinding to replace hydrocolloids like carrageenan, xanthan, guar or locust bean. Although quite effective in waterbinding, disadvantage of the latter compounds is that digestion in the gut is not without difficulties so that phenomena like diarrhoea and flatulence can occur. The following recipe specifies a canned meat product from which hydrocolloids have been removed and replaced by potato protein.

30

|                            | w/w   |
|----------------------------|-------|
| Meat (chunks)              | 50%   |
| Water                      | 37.5% |
| Undenatured potato protein | 4%    |
| 35 Plasma                  | 0.5%  |
| Gelatin                    | 3%    |
| Flour                      | 5%    |

After preliminary mixing of the ingredients, water is added. The wet mix is then filled into cans and sterilised. Gelling occurs during sterilisation.

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**Example 13 Low Fat Yogurt**

Potato protein was evaluated in a low fat yogurt formulation which was cultured with the protein present.

|   |                        |              |
|---|------------------------|--------------|
| 5 | <b>Ingredients</b>     | <b>% w/w</b> |
|   | 1. Skimmed Milk Powder | 3.5          |
|   | 2. Skimmed Milk        | 96.5         |

**Preparation Method:**

- 10 1. Switch on the proving oven and start boiling the water in the bain marie
2. Weigh milk into bain marie
3. Disperse blended dry ingredients into milk using whisk
4. Place wooden spoon in bain marie and tare balance
- 15 5. Heat and hold the milk for 7 minutes at 90°C, stirring continuously
6. Remove from heat and add back lost water
7. Cool samples to 44°C in the cold store
8. Make up the culture - 10 grams of culture to 100 grams of skimmed milk
- 20 9. To each 1 kg batch add 4 grams of culture mix. Culture all batches at the same time
10. Pour 800 grams into labelled Hamilton beakers
11. Incubate in the proving oven until the pH is between 4.6 - 4.7
- 25 12. Remove from the proving oven and Braun (shear) each yogurt in the Hamilton beakers. 10 short bursts - any viscosity lost will recur once cooled
13. Cool to 20°C in a sink with the coll packs and water
- 30 14. Parafilm the beakers and place in cold store overnight

**The following day:**

- 15 15. Measure the pH (approximately pH 4.2), mix the yogurts well with a hand whisk and transfer into pots
16. Silversoning grainy yogurts (fine head, 3000rpm for 2 minutes) at this stage gives a smooth final product

The samples which were evaluated were (i) low fat yogurt  
40 (reference) and (ii) low fat yogurt + 1% potato protein

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The results were as follows:

The reference yielded a yogurt with a thin, smooth and continuous texture, typical of low-fat yogurt. The potato protein yogurt had thicker texture than the reference, which can be attributed to its outstanding gelling properties.

#### Example 14 Whipped Cream

An assessment of whipping capability was made through addition of 1% potato protein to double cream (48% milk fat) and whisking the resulting mixture for 3 minutes. The samples evaluated in this way were as follows:

- (i) Double cream (reference)
- (ii) Double cream + 1% potato protein
- (iii) Double cream + 1% sodium caseinate

The results were as follows:

- (i) Double cream: after 3 minutes, the cream had formed a texture like butter.
- (ii) Double cream + 1% potato protein: after 3 minutes, the foam successfully held air, it was softer than the double cream and almost cuttable and pasty.
- (iii) Double cream + 1% sodium caseinate: after 3 minutes, the cream plus caseinate had formed butter similar to the cream alone.

This shows that potato protein can form a stable foam at long whisking. It also shows that potato protein can be used to form a stable foam in the presence of high fat (48% milk fat). These observations are unusual for protein foaming agents, which tend to form a butter at long whisking.

#### Example 15 Imitation Whipping Cream

Imitation whipping cream formulations normally contain sodium caseinate. This example shows the impact of replacing the caseinate with undenatured potato protein or water.

40

Ingredients

Reference

Test 1

Test 2

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|      |                              | % w/w  | %w/w   | % w/w  |
|------|------------------------------|--------|--------|--------|
| 1    | Skimmed Milk Powder Sol.(9%) | 61.903 | 61.903 | 61.903 |
| 2    | Hydrogenated Palm Kernal Oil | 29.000 | 29.000 | 29.000 |
| 5 3  | Sucrose                      | 5.000  | 5.000  | 5.000  |
| 4    | Sodium Caseinate-Alanate 180 | 3.000  | -      | -      |
| 5    | Acidin N12 Veg               | 0.800  | 0.800  | 0.800  |
| 6    | Panodan-165                  | 0.100  | 0.100  | 0.100  |
| 7    | Alginate-FD155               | 0.070  | 0.070  | 0.070  |
| 10 8 | Cream Flavour-LC 24049 WA    | 0.125  | 0.125  | 0.125  |
| 9    | Beta-Carotene-5% Emulsion    | 0.002  | 0.002  | 0.002  |
| 10   | Water                        | -      | 3.000  | -      |
| 11   | Potato Protein               | -      | -      | 3.000  |

15

**Preparation Method**

1. Shear in the skimmed milk powder and potato protein when added. Allow to hydrate overnight.
2. Melt the HPKO and Acidin N12 Veg in the microwave until  
20 liquid.
3. Add the panodan, sodium caseinate, betacarotene and flavour to the skimmed milk powder solution. Heat to 70°C. Dry blend the alginate with sugar and disperse into the heated skimmed milk powder solution, mix in well.
- 25 4. Add the fat phase and heat to 85°C, hold for 15 seconds and cool to 75°C.
5. Shear using the ultratorrex on a medium speed for 2 minutes.
6. Cool rapidly, stirring at regular intervals.
7. Age for 24 hrs before whipping.
- 30 8. Whisk in a Hobart bowl for 4 minutes on speed 3.
9. Transfer to suitable container.

After preparation, the imitation cream formulations were aged at 4°C for 24 hours prior to evaluation by whipping on a Hobart  
35 mixer at speed 3 for 4 minutes. The potato protein imitation whipping cream could be stored for 48 hrs at 4°C without syneresis (phase separation), which was observed in the other two samples.

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**Example 16 Confectionery formulation**

Undenatured potato protein was used in a confectionery formulation using the following recipe.

5

**Ingredients:**

157 ml light corn syrup

72 ml light brown sugar

30 ml hot water

10 30 g (10%) native potato protein

1. Make a hot sugar syrup, by boiling to 100°C (special procedure for specific sugar crystallisation)
2. Whip whipping agent until stiff point
- 15 3. Add hot sugar syrup while whipping
4. Pour in container (store: 7°C, 20°C)

A foamed product was formed. This shows that undenatured potato protein of the invention also retains its foaming capacity in the  
20 presence of high sugar syrup.

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## CLAIMS

1. A process for the preparation of undenatured potato protein in which a fraction comprising undenatured potato protein is subjected to concentration and, optionally, drying which process is characterised in that the temperatures in the steps preceding the drying of the fraction do not exceed 40°C.
2. A process according to claim 1 which is characterised in that the fraction comprising the undenatured potato protein is subjected to a pre-treatment at a temperature in the range of 10 to 40°C before the fraction is concentrated.
3. A process according to claim 1 or 2 which is characterised in that the fraction comprising the undenatured potato protein is concentrated at a temperature in the range of 15 to 25°C, and, optionally, dried at a product temperature which does not exceed 75°C.
4. A process according to claim 2 or 3, which is characterised in that the fraction comprising the undenatured protein is pre-treated by flocculation.
5. A process according to claim 4, which is characterised in that the flocculation is carried out by mixing the fraction comprising the undenatured potato protein with calcium and phosphate compounds.
6. A process according to claim 1-5, which is characterised in that the fraction comprising the undenatured potato protein is concentrated by ultrafiltration.
7. A process according to claim 1-6, which is characterised in that the concentrate is dried by freeze-drying at a temperature lower than 35°C.

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8. A process according to claim 6, which is characterised in that the concentrate after ultrafiltration is subjected to diafiltration before the concentrate is dried.
- 5 9. A process according to claim 1-8, which is characterised in that the fraction comprising the undenatured potato protein is potato fruit juice.
- 10 10. A food composition comprising undenatured potato protein as obtainable by a process according to claims 1-9 as an additive or an ingredient.
11. A food composition according to claim 10 which is essentially a non-potato food product.
- 15 12. A food composition according to claim 11 in which all or a portion of the fat, protein or hydrocolloids is replaced by undenatured potato protein.
- 20 13. A food composition according to claim 12, wherein the food composition is a bakery product, preferably a pastry.
14. A whipped food composition comprising undenatured potato protein as an ingredient.
- 25 15. A meringue in which all or a portion of the egg white is replaced by undenatured potato protein.
16. A mousse in which all or a portion of the egg white or casein is replaced by undenatured potato protein.
- 30 17. A food composition according to claim 12, wherein the food composition is a dairy, meat, pet food or fish product.
- 35 18. A process for the preparation of a fat substitute comprising processing undenatured potato protein.

- 20 -

19. A fat substitute obtainable by a process according to claim 18.
20. A method for changing a food composition comprising the addition of undenatured potato protein to said food composition, optionally replacing all or a part of a constituent selected from the group consisting of fat, protein and hydrocolloids.
21. The use of undenatured potato protein to minimise syneresis in a whipped food product.
22. The use of undenatured potato protein to completely or partially replace fat, protein or hydrocolloids.

15

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 97/02596

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 A23J1/16 A23L1/305 A23P1/16 A23K1/18 A23C9/13  
A23C13/00 A23L1/19 A23G3/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A23J A23L A23P A23K A23C A23G A21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                            | Relevant to claim No. |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X          | DE 29 43 190 A (RHONE POULENC IND) 30<br>April 1980<br>see page 8, last paragraph - page 9,<br>paragraph 3<br>see example 5<br>see claim 1                                                                    | 1,9,10                |
| X          | M.C. PORTER ET AL.: "Membrane<br>Ultrafiltration"<br>CHEMICAL TECHNOLOGY,<br>1971,<br>pages 636-637, XP002041358<br>see page 636, column 2, last paragraph -<br>page 637, column 1, paragraph 2<br>---<br>-/- | 1,6,9,10              |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents:

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- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search

22 September 1997

Date of mailing of the international search report

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax (+31-70) 340-3016

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Dekeirel, M

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 97/02596

| C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                                                                                                                                                                                                                                              |                       |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Category                                             | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                                                           | Relevant to claim No. |
| X                                                    | GB 1 520 738 A (SCHOLTEN HONIG NV) 9<br>August 1978<br>see page 1, line 58 - line 73<br>see page 2, line 8 - line 14<br>see page 2, line 78 - line 111<br>see claims 1,4,6-8,10,16-18                                                                                                                                                                                        | 1,2,4-6,<br>8-10      |
| Y                                                    | see page 3, line 30 - line 40<br>---                                                                                                                                                                                                                                                                                                                                         | 11-22                 |
| Y                                                    | HOLM F: "A NEW SYSTEM FOR THE PRODUCTION<br>OF STARCH AND PROTEIN FROM POTATO"<br>STARCH STARKE,<br>vol. 32, no. 8, August 1980,<br>pages 258-262, XP000604946<br>see page 258, column 1, Abstract<br>see page 261, column 2, paragraph 4<br>see page 262, column 1, paragraph 1<br>---                                                                                      | 11,<br>14-16,21       |
| Y                                                    | HOLM F: "NEW PROCESS ACHIEVES GREATER<br>YIELDS IN POTATO STARCH AND PROTEIN<br>PRODUCTION"<br>FOOD ENGINEERING INTERNATIONAL,<br>vol. 2, no. 2, February 1977,<br>page 49/50 XP000603951<br>see page 49, column 1, paragraph 3<br>see page 50, column 1, paragraph 1<br>see page 50, column 3, paragraph 1 -<br>paragraph 2<br>---                                          | 11-13,<br>17-20,22    |
| A                                                    | HOLM F ET AL: "EMULSIFYING PROPERTIES OF<br>UNDENATURATED POTATO PROTEIN CONCENTRATE"<br>JOURNAL OF FOOD TECHNOLOGY,<br>vol. 15, no. 1, 1980,<br>pages 71-83, XP002015268<br>cited in the application<br>see page 71, paragraph 1 - paragraph 7<br>see page 72, paragraph 3<br>see page 78, last paragraph - page 83,<br>paragraph 4<br>---                                  | 10-22                 |
| A                                                    | JACKMAN R L ET AL: "FUNCTIONAL PROPERTIES<br>OF WHEY-POTATO PROTEIN COMPOSITE BLENDS IN<br>A MODEL SYSTEM"<br>JOURNAL OF FOOD SCIENCE,<br>vol. 53, no. 5, 1988,<br>pages 1427-1432, XP002015269<br>cited in the application<br>see page 1427, column 1, paragraph 1 -<br>paragraph 3<br>see page 1428, column 1, last paragraph -<br>page 1432, column 2, paragraph 2<br>--- | 10-22                 |
|                                                      | -/--                                                                                                                                                                                                                                                                                                                                                                         |                       |

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 97/02596

| C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                                                                                                                                                                                        |                       |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Category                                             | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                     | Relevant to claim No. |
| A                                                    | S. ERIKSEN: "Protein nutritional quality of air-classified potato fractions"<br>JOURNAL OF FOOD SCIENCE,<br>vol. 46, no. 2, 1981, CHICAGO US,<br>pages 540-542, XP002015270<br>see page 540, column 1, paragraph 1 -<br>paragraph 4<br>see page 541, column 1, paragraph 2 - page<br>542, column 2, paragraph 3<br>--- | 10-22                 |
| A                                                    | US 3 617 307 A (INKLAAR PETRUS ADAM) 2<br>November 1971<br>see claims 1,2,12<br>---                                                                                                                                                                                                                                    | 1,10-12,<br>17        |
| A                                                    | EP 0 057 989 A (UNILEVER PLC ;UNILEVER NV<br>(NL)) 18 August 1982<br>see page 1, line 3 - line 9<br>see page 5, line 7 - line 11<br>see page 8, line 8 - page 9, line 8<br>see example 11<br>see claims 1,5,6,9,14<br>---                                                                                              | 1,10                  |
| A                                                    | DE 688 659 C (NORDDEUTSCHE<br>KARTOFFELMEHL-FABRIK) 27 February 1940<br>see page 2, line 1 - line 55<br>see page 2, line 90 - line 100<br>-----                                                                                                                                                                        | 1                     |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 97/02596

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                                                                                              | Publication<br>date                                                                          |
|-------------------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| DE 2943190 A                              | 30-04-80            | FR 2439791 A<br>BE 879679 A<br>JP 1146051 C<br>JP 55085365 A<br>JP 57037307 B<br>NL 7907901 A                                           | 23-05-80<br>28-04-80<br>12-05-83<br>27-06-80<br>09-08-82<br>29-04-80                         |
| GB 1520738 A                              | 09-08-78            | DE 2542155 A<br>FR 2285079 A<br>JP 51063200 A<br>NL 7510937 A<br>SE 7510598 A                                                           | 01-04-76<br>16-04-76<br>01-06-76<br>25-03-76<br>24-03-76                                     |
| US 3617307 A                              | 02-11-71            | NL 6501845 A<br>BE 676494 A<br>CH 519859 A<br>DE 1692812 A<br>FR 1500788 A<br>GB 1141811 A<br>LU 50460 A<br>SE 343464 B<br>US 3552978 A | 16-08-66<br>16-08-66<br>15-03-72<br>16-03-72<br>25-01-68<br>15-02-67<br>13-03-72<br>05-01-71 |
| EP 0057989 A                              | 18-08-82            | DK 24782 A<br>US 4404228 A                                                                                                              | 22-07-82<br>13-09-83                                                                         |
| DE 688659 C                               |                     | NONE                                                                                                                                    |                                                                                              |

